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DEPARTMENT OF NURSING EDUCATION

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A COURSE IN CHEMISTRY FOR STUDENT NURSES

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What benefit is to be derived from a knowledge of chemistry, except when such knowledge be used in a technical way? This is an important question when we come to consider the teaching of chemistry to student nurses.

It has been recognized pretty generally in recent years that all college students should spend at least one year in the study of some scientific subject, whether it be chemistry, physics, botany, zoölogy, or biology. Such study is not advised with the thought that the knowledge will ever be of much practical use to the individual, but its purpose is rather to add to the general cultural effect of the college education, that is, to aid in acquainting the student with the past and present of his surroundings and to give him a deeper appreciation of life in all its forms. We are all interested in the processes going on around us just in proportion as we comprehend their significance and understand what forces are acting to produce the observed effects.

Take, for instance, the changes observed in such a simple substance as water What do most people see of interest in this common substance? Nothing, except to marvel at the beauties of frost crystals on the windows and at the fresh whiteness of the snow. The changes that water undergoes are in evidence all around us so constantly that we do not even wonder at the forces producing such changes, and yet how interesting these same processes become if we gain an insight into their nature. Take, for instance, the simple boiling of water; what are the bubbles of gas rising to the surface and escaping; what causes their continued formation in the water; just how do the water molecules effect the change from liquid to gaseous state; why will water boil at a lower temperature at high altitudes and at higher temperatures under pressure? These and a dozen other questions render this simple phenomenon very interesting indeed to the knowing observer. Or we might ask how many see anything interesting, except in a commercial way, in the storage of what we term foodstuffs by various plants, such as corn, wheat, oats, rye, etc. Would not farming be more fascinating if the farmer could picture the forces causing this storage of food material, the part played by the sunlight and chlorophyl, the carbon dioxide of the air and water of the earth?

But for nurses and physicians, especially, who are dealing with human bodies directly in most of their working hours, would it not add greatly to the pleasure and the intelligence of their work if they could have a clear mental picture of all the physiological processes of the patient and how these might be altered pathologically? At present such mental pictures must of necessity be somewhat vague because of lack of absolute knowledge, but all that is available should be at hand. The tendency now in the better schools of nursing is to give the student nurse ever-increasing amounts of knowledge of the human body. This knowledge of the patient can come only through a comprehension of the chemical and physical processes involved in the performance of the body functions. After all, the nurse has entire charge of the patient a major part of the time.

Another direction in which the nurse should be especially prepared is in regard to the composition of foods, food values and the proper arrangement of different diets. In this respect her knowledge should surely equal that of the physician, if not exceed it. The physician is called upon to decide what kind of diet is indicated, but the practical application of the diet comes more in the sphere of the nurse.

Now to accomplish the desired general cultural effect of scientific study and to give the student nurse the greatest possible knowledge of the human body, in the one semester that is available at present, what kind of a course in chemistry should be given? This will depend somewhat on the class of students available. In those schools not requiring a high school education, the problem is difficult and the results will be less satisfactory, but with high school graduates matriculating as regular college students, practically all of whom have had one year of study in some science (physics, chemistry, or biology), surprising advance may be made toward a somewhat comprehensive general knowledge of chemical processes, and in particular of those occurring in the body. The character and content of such a course as successfully given in the School of Nursing and Health of the University of Cincinnati is indicated below.

The course covers one semester of 16 weeks and consists of 45 hours of lectures and 90 hours of laboratory work. The lectures may be roughly divided as follows: General introduction, 3 hours; inorganic chemistry, 8 hours; organic chemistry, 8 hours, and physiological chemistry, 26 hours, which are divided into carbohydrates, 3 hours; fats, 3 hours; proteins, 4 hours; digestion, 4 hours; blood, 3 hours; excretion and urine, 3 hours; metabolism in body, 4 hours; starvation, internal secretions and vitamines, 2 hours.

In the general introduction the aim and purposes of the course are put before the students, making as clear as possible the benefits they may derive from the work in a general cultural and in a practical way. An attempt is made to give some workable imaginary picture of atoms and molecules that the students may use in picturing to themselves the reactions. A few fundamental definitions are given. The different states of matter, with changes from one state to another, are discussed and taken up in some detail for water. The heat transformations in passing from ice to steam are emphasized, especially the high heat of vaporization, since this fact has great significance in perspiration.

Inorganic chemistry is dealt with as briefly as possible, still leaving with the student a general knowledge of the subject. The nonmetals (H, O, C, N, S, P, Cl, Br, I, Fl) are each taken up briefly as regards their occurrence, state, activity, combinations, etc. The burning of these elements, except the halogens, with oxide formation is dwelt upon, as well as the acid formation from these oxides. The halogens are discussed as a separate subdivision, the points of similarity being noted. Next the metals are briefly classified and discussed by classes, pointing out individual points of interest in regard to each metal. Acids, bases and salts are then taken up, together with considerable drill in writing equations for reactions.

Organic compounds are considered by classes, as hydrocarbons (saturated and unsaturated), alcohols, aldehydes, acids, ethers, esters, etc. The interrelation of the classes is emphasized, together with the changing of a substance from one class to another by oxidation or reduction (except for ethers and esters). The members of each class in common usage are discussed as examples of the class. The attempt throughout is made to give the students a connected, comprehensive idea of the whole field, without burdening them with a mass of details. The polyhydric alcohols are discussed briefly, especially glycerine, in order to lead up to the carbohydrates and fats later. The dicarboxyllic and tricarboxyllic acids (tartaric, oxalic, citric) are mentioned because of the frequency of their use in foods and medicine. Aromatic compounds are taken up very briefly, giving the formulas of the simpler aromatic drugs such as phenol, aspirin, sodium salicylate, etc. Amino acids are defined, their relation to fatty acid shown, and their importance in protein formation pointed out.

Almost sixty per cent of the course is spent in the study of physiological chemistry, and this represents the relative importance of this part of the work in the writer's opinion. The chief aim of the course, then, is to give to the students a fair understanding of the chemistry of the body processes. Much benefit is derived from explaining those inorganic and organic chemical reactions with which the nurse deals constantly in her work with drugs and solutions, but to make this the principal aim of the course, as is done by most of the writers of chemistry textbooks for student nurses, so far, seems to the writer to be a grievous error. It is the human body upon which the nurse focuses most of her attention and it should certainly be made possible for her to understand this main point of interest. The fact that the course deals mainly with the human body lends much more interest to the work, so that there is never any lack of attention on the part of the students. The results obtained are highly satisfactory.

The laboratory work is given in two three-hour periods a week and constitutes for each student the following experiments:

INORGANIC CHEMISTRY

Preparation and properties of hydrogen; preparation and properties of oxygen; test for presence of CO_2; neutralization of an acid by a base; separation by distillation; preparation and properties of iodine; solubility of iodine; tests for iodine; preparation and properties of acetylene gas; preparation and properties of CO.

ORGANIC CHEMISTRY

Qualitative analysis of cane sugar; saturated and unsaturated hydrocarbons; iodoform test for alcohol; aldehyde formation from alcohol; acetate test for alcohol, oxidation of alcohols to aldehydes; detection of formaldehyde in milk; reducing test for aldehydes; properties of acetic acid; higher fatty acids; dibasic organic acids; esters.

PHYSIOLOGICAL CHEMISTRY

Fats and saponification; solubility of fats; acrolein test for fats; Fehling's test for carbohydrates; hydrolysis of a disaccharide; color test for carbohydrates,—Molisch; fermentation of carbohydrates by yeast; composition of proteins; color reactions of proteins; biuret, Millon, xanthoproteic, Molisch, reduced sulphur reaction; heat coagulation of proteins; coagulation by alcohol; precipitation of proteins by salts,—"Salting out"; precipitation of proteins by salts of heavy metals.

Digestion: Action of saliva; clotting of milk by rennin; digestion of proteins by pepsin; pancreatic digestion of starch; fat digestion.

Blood: Swelling and shrinking of corpuscles; hypertonic, hypotonic and isotonic solutions; hemolysis or laking of red corpuscles; "Ghosts" of red cells after laking; coagulation of blood; properties of hemoglobin; properties of blood fibrinogen.

Urine: Reaction; specific gravity; test for chlorides; test for sulphates; test for phosphates; indican test; test for proteins in urine; test for creatinine; test for glucose; test for bile pigments; test for blood in urine; preparation of urea.

Quantitative urine analysis (24 hour samples of urine collected under different conditions, such as high protein diet, low protein diet, high phosphorous diet, and starvation): volume; specific gravity; total acidity or alkalinity; total nitrogen; ammonia; creatinine; glucose; protein.

The laboratory equipment for each student comprises the following articles:

NET COST OF EQUIPMENT OF NURSE'S DESK

1 box filter paper, 60 mm	$ .10
1 box matches	.02
1 test tube brush	.03
1 wire gauze square	.04
1 beaker, low, with lip, 150 cc	.15
2 beakers, low, with lip, 250 cc	.50
1 beaker, low, with lip, 500 cc	.30
2 bottles, narrow mouth, 90 cc and 1000 cc	.20
4 bottles, wide mouth, 250 cc	.20
1 burner, Bunsen, with rubber tubing	.53
1 clamp and attachment, iron	.18
1 cylinder graduate, 100 cc	.50
1 deflagrating spoon	.07
2 evaporating dishes, procelain, 7 cm. and 10 cm.	.35
1 file, triangular	.06
3 flasks, Florence, 150 cc, 300 cc, and 500 cc	.80
2 funnels, 5 cm. and 10 cm.	.60
1 funnel support	1.25
4 glass plates, 3 x 3 inches	.40
1 mortar and pestle, porcelain	.21
2 pinch clamps, Mohr's	$ .34
1 ring stand	.48
3 rings, iron	.24
1 spatula, horn	.26
12 test tubes, 6 inch	1.80
1 test tube, side neck	.15
1 test tube holder	.10
1 test tube rack	.26
1 test tube, hard glass	.11
1 Thermometer, 150° c.	.68
1 tripod, iron	.18
1 tube, thistle	.11
1 watch glass, 50 mm.	.03
2 watch glasses, 100 mm.	.12
1 gas collecting tube	--
1 water bath	--
1 condenser, Liebig's	1.25
4 ft. rubber tubing	.24
1 fermentation tube	.20
1 ureometer	1.25
1 hydrometer	1.30
1 burette, 50 cc graduate	.55
Total	$16.14
1 Dubosque colorimeter	85.25

The total estimated cost per desk is about $16.00. Such an outfit might well serve for two students where funds are limited. The colorimeter ($85.25) is used only for the creatinine determination, and might be omitted if necessary. A rough estimate of the value of the chemicals used by each student gives $1.50 to $2.00. Besides this there is usually a breakage charge of $1.10 to $1.25 per student for glassware and rubber tubing destroyed.

The laboratory work is given here in the regular medical biochemical laboratory and the experiments were so selected as to use the chemicals and solutions already on hand for the medical biochemistry class. This simplifies the laboratory work very much.

As textbooks for the course, there is no one that is satisfactory for the whole course. The one recently published by Professor Annie Louise Macleod of Vassar College is perhaps the most nearly the desired kind so far as its table of contents indicates, but the treatment is entirely too limited throughout to give the broad view of the subject desired. So far we have merely referred the students for supplementary reading to any good inorganic and organic chemistry available, and to Mathews' Physiological Chemistry for the rest. This is not satisfactory because of the mass of details given in such books which only acts to confuse the students and sometimes causes them to miss the important points.

There is undoubtedly a serious need of a proper textbook of chemistry for the use of student nurses. This is made very evident by the large number already on the market.

So much for the course in chemistry. Now how about teachers to give such a course? What qualifications are necessary or advisable? It is well known that no one can teach well that with which he himself is not thoroughly familiar. Nothing so well shows a person how little he knows of a subject as the attempt to make that subject really clear to students in a limited time. We may say, in general, that for one to have the proper background for the presentation of chemistry to student nurses, one should have had good courses in physics, physical chemistry, inorganic chemistry, quantitative analysis, organic chemistry, physiological chemistry, and as much work in the biological sciences as possible. Botany and zoölogy are not necessary, but would give a useful addition to the background. Human anatomy and physiology should be included by all means, while pharmacology, pathology and bacteriology will be found very useful at times. It really amounts to saying that the instructor should be a chemist and a biologist combined in order to make the most of chemistry from the view point of the nurse's needs.